

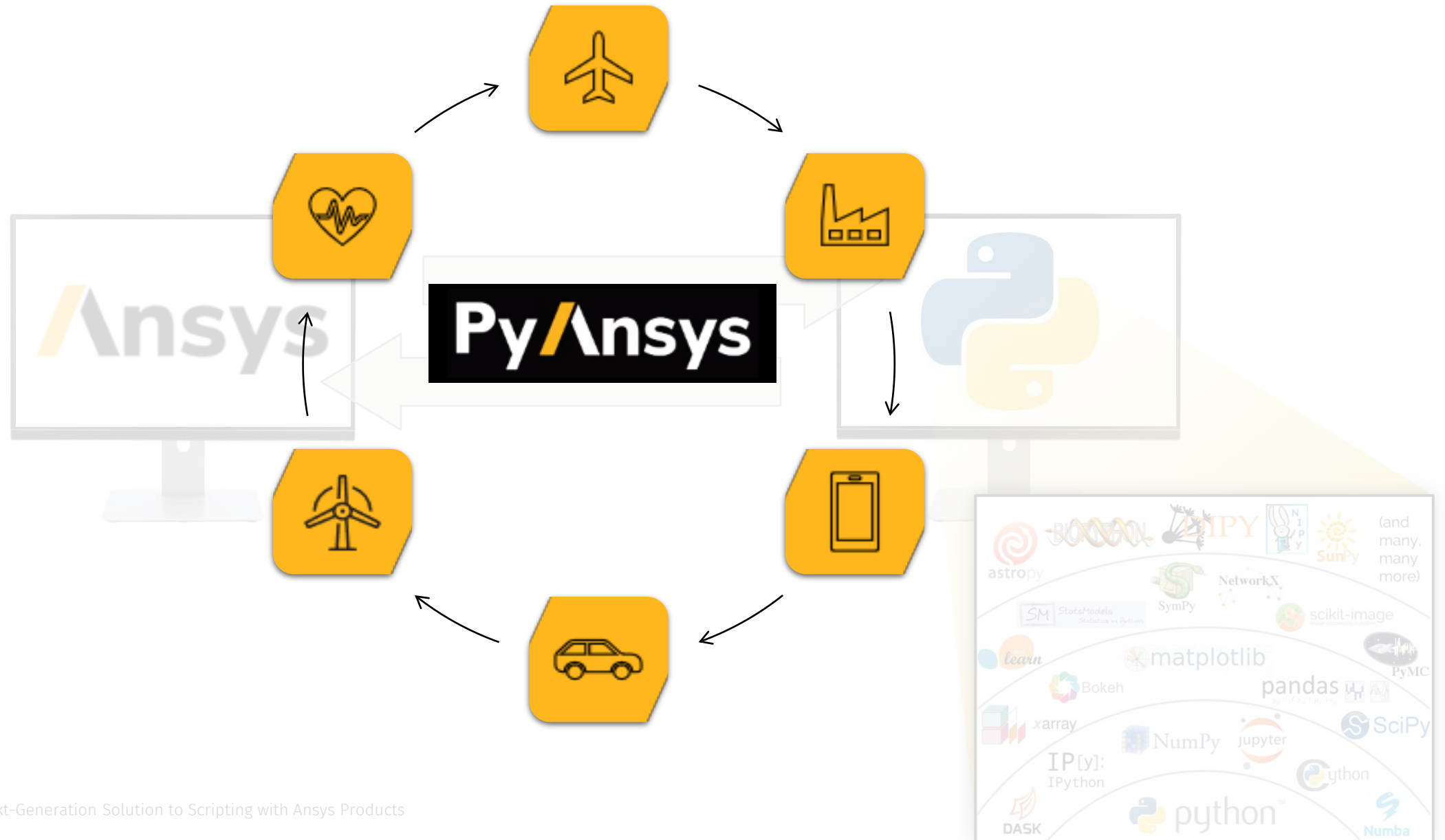
Bateriové systémy
Umělá inteligence
Numerické simulace
AUTONOMNÍ SYSTÉMY
OBRANNÝ PRŮMYSL
Rozšířená realita

30/Ansys
KONFERENCE
25.-27. 10. 2023

PyAnsys: A Next-Generation Solution to Scripting with Ansys Products

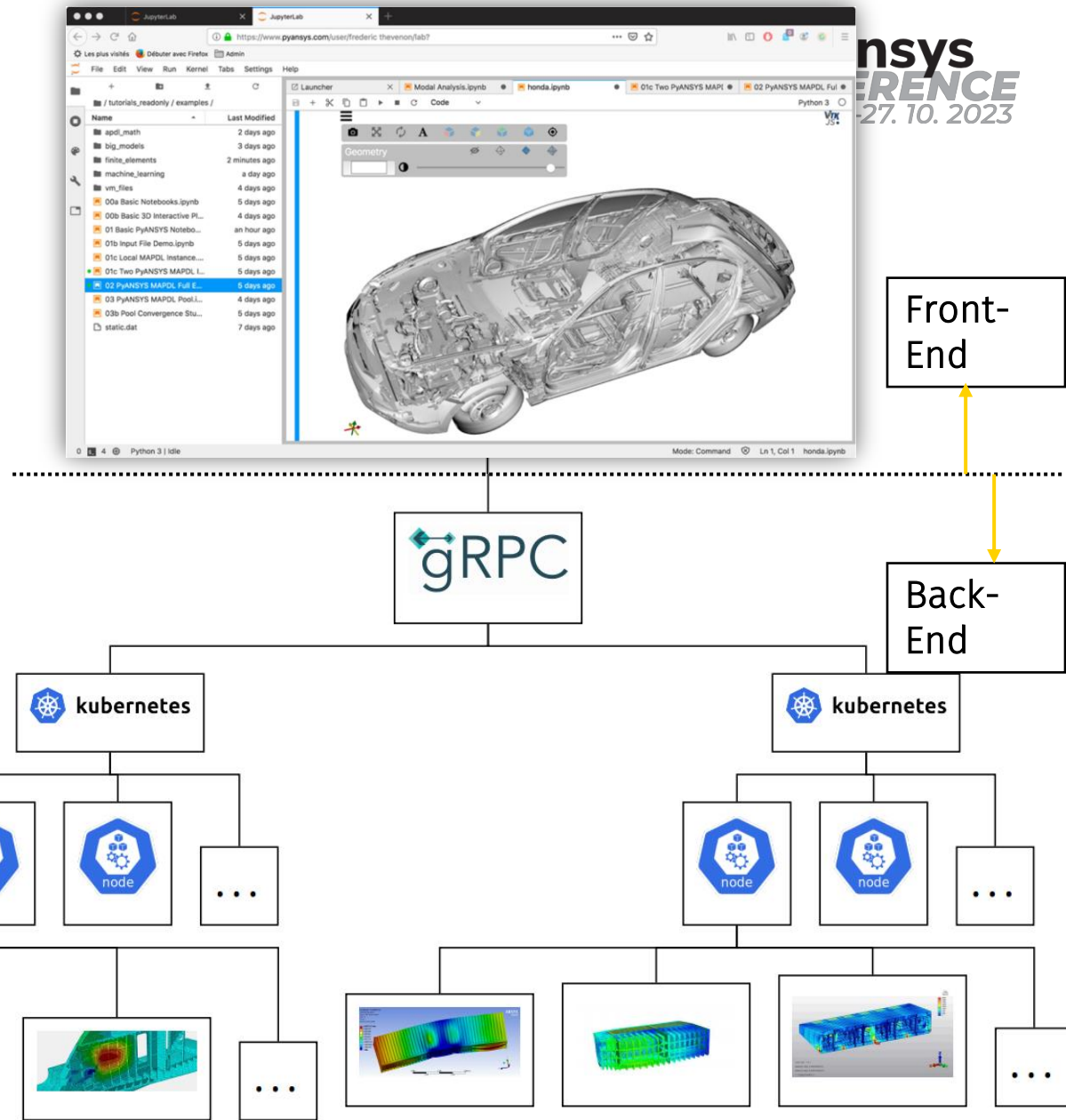
Zdeněk Čada

What is PyAnsys?



Why use it & Innovation offered?

- The PyAnsys project is **Ansys's commitment to open-source** where we provide Python libraries that expose Ansys technologies in the Python ecosystem through APIs and interfaces that are **clear, concise, and maintainable**. This allows Ansys Customers to do.



nsys
REFERENCE
27. 10. 2023

How to get started with PyAnsys (local installation)?

3 Step Process:

1. Install Ansys
2. Install Python and an IDE of your choice (Spyder, Jupyter, Jupyter Lab, ...)
3. Install PyAnsys modules

Downloads: Current Release - 2021 R2

Select Release: **2021 R2** Select Operating System: **Windows x64**

Windows x64 packages are displayed

Release version	Release date	Download	Click for more
Python 3.9.0	Oct. 5, 2020	Download	Release Notes
Python 3.8.6	Sept. 24, 2020	Download	Release Notes
Python 3.5.10	Sept. 5, 2020	Download	Release Notes
Python 3.7.9	Aug. 17, 2020	Download	Release Notes
Python 3.6.12	Aug. 17, 2020	Download	Release Notes
Python 3.8.5	July 20, 2020	Download	Release Notes
Python 3.8.4	July 13, 2020	Download	Release Notes

Operating System	Description	MD5 Sum	File Size	GPG
Source release		bcd9f22cf531efc6f06ca6b9b2919bd4	23277790	SIG
Source release		389d3ed26b4d97c741d9e5423da1f43b	17389636	SIG
Mac OS X	for OS X 10.9 and later	4b544fc0ac8c3cfffdb67dede23ddb79e	29305353	SIG
Windows		1094c8d9438ad1adc263ca57ceb3b927	8186795	SIG
zip file	for AMD64/EM64T/x64	60f77740b30030b22699dbd14883a4a3	7502379	SIG
installer	for AMD64/EM64T/x64	7083fed513c3c9a4ea655211df9ade27	26940592	SIG
installer	for AMD64/EM64T/x64	da0b17ae84d6579f8df3eb24927fd825	1348904	SIG
file		97c6558d479dc53bf448580b66ad7c1e	6659999	SIG
installer		1e6d31c98c68c723541f0821b3c15d52	25875560	SIG
installer		22f68f09e533c4940fc006e035f08aa2	1319904	SIG

```
python -m venv PyAnsys
call PyAnsys\Scripts\activate
pip install jupyterlab
pip install ansys-mapdl-core
pip install ansys-mapdl-reader
pip install pyaedt
pip install ansys-dpf-core
pip install ansys-dpf-post
```


PyMAPDL

- ❑ With PyMAPDL, it's possible to:
 - Create geometry, mesh, model setup
 - Do interactive plotting
 - Post-process
 - Translate MAPDL scripts to PyMAPDL script

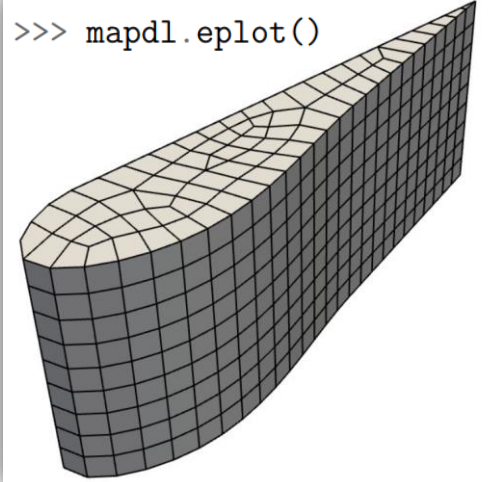
- ❑ Either use standard APDL commands through "Run" command, or call MAPDL Pythonically:

PyAnsys Code Example: Meshing

```
>>> mapdl.et(1, 'SOLID186')
>>> mapdl.v sweep('ALL')
>>> mapdl.esize(0.1)
>>> mapdl.mesh

ANSYS Mesh
Number of Nodes:           7217
Number of Elements:       2080
Number of Element Types:  2
Number of Node Components: 0
```

```
>>> mapdl.eplot()
```



```
POST1:
PRNSOL, U, X

PRINT U  NODAL SOLUTION PER NODE

***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

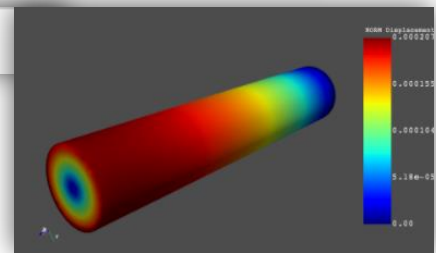
LOAD STEP= 1  SUBSTEP= 1
TIME= 1.0000  LOAD CASE= 0

THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN THE GLOBAL COORDINATE SYSTEM

NODE      UX
1  0.10751E-003
2  0.85914E-004
3  0.57069E-004
4  0.13913E-003
5  0.35621E-004
6  0.52186E-004
7  0.30417E-004
```

```
>>> mapdl.set(1, 1)
>>> disp_x = mapdl.post_processing.nodal_displacement('X')
array([1.07512979e-04, 8.59137773e-05, 5.70690047e-05, ...,
       5.70333124e-05, 8.58600402e-05, 1.07445726e-04])
```

```
>>> mapdl.post_processing.plot_nodal_displacement('X')
```

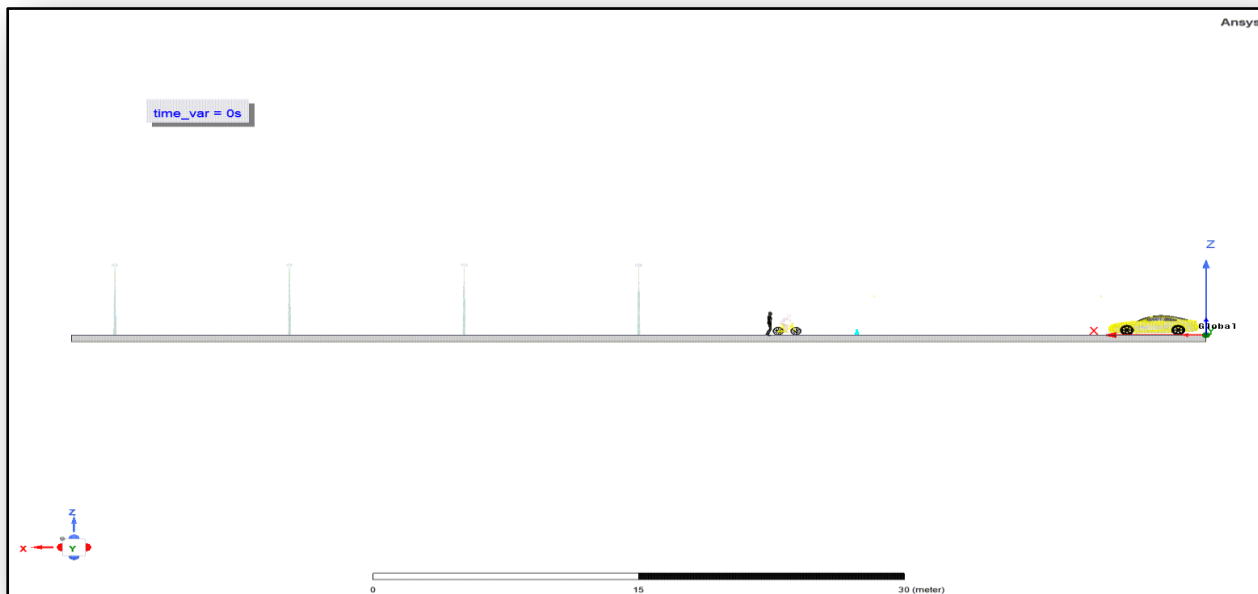
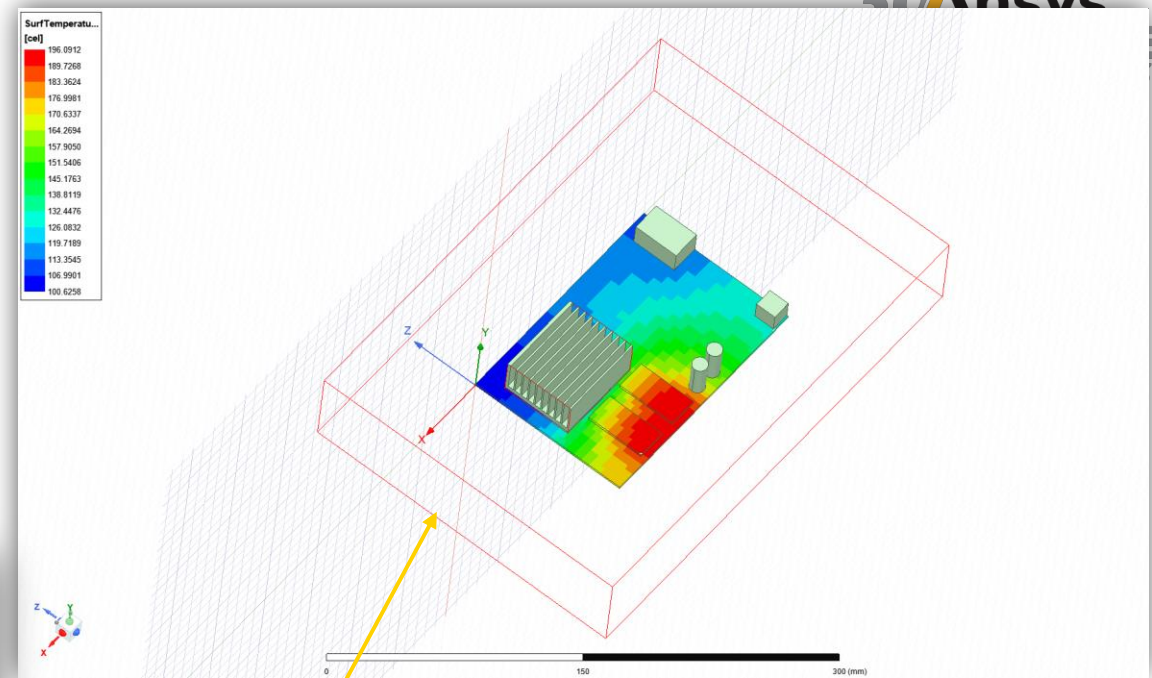


```
mapdl.run('/PREP7')
mapdl.run('K, 1, 0, 0, 0')
mapdl.run('K, 2, 1, 0, 0')
mapdl.run('K, 3, 1, 1, 0')
mapdl.run('K, 4, 0, 1, 0')
mapdl.run('L, 1, 2')
mapdl.run('L, 2, 3')
mapdl.run('L, 3, 4')
mapdl.run('L, 4, 1')
mapdl.run('AL, 1, 2, 3, 4')
```

```
mapdl.prep7()
mapdl.k(1, 0, 0, 0)
mapdl.k(2, 1, 0, 0)
mapdl.k(3, 1, 1, 0)
mapdl.k(4, 0, 1, 0)
mapdl.l(1, 2)
mapdl.l(2, 3)
mapdl.l(3, 4)
mapdl.l(4, 1)
mapdl.al(1, 2, 3, 4)
```

PyAEDT

- ❑ With PyAEDT, it's possible to:
 - Create a Full Electronics Desktop Workflow in CPython
 - Interact with EDB Files (PCB)
 - Do interactive plotting & Post-process
 - Build Custom Workflows



Solve and PostProcess

Solve Project and plot Temperatures

```

•[9]: quantity_name = "SurfTemperature"
surflist = [i.id for i in ipk.modeler.primitives["CPU"].faces]
surflist += [i.id for i in ipk.modeler.primitives["MEMORY1"].faces]
surflist += [i.id for i in ipk.modeler.primitives["MEMORY1_1"].faces]
surflist += [i.id for i in ipk.modeler.primitives["ALPHA_MAIN_PCB"].faces]

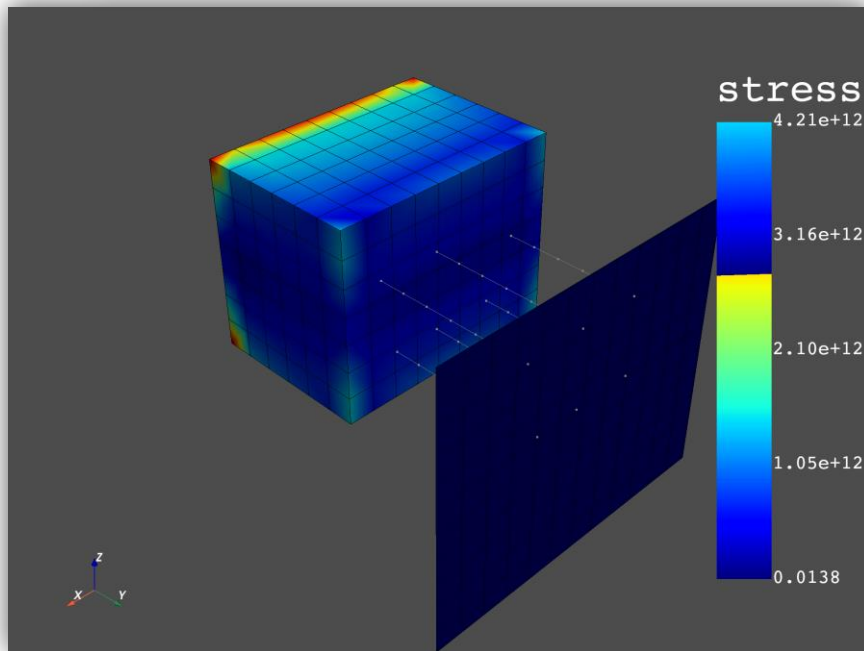
plot5 = ipk.post.create_fieldplot_surface(surflist, "SurfTemperature")
    
```

PyDPF-Post

Run simulation in ANSYS and save binary result file (.rst)

Plot the amplitude contour

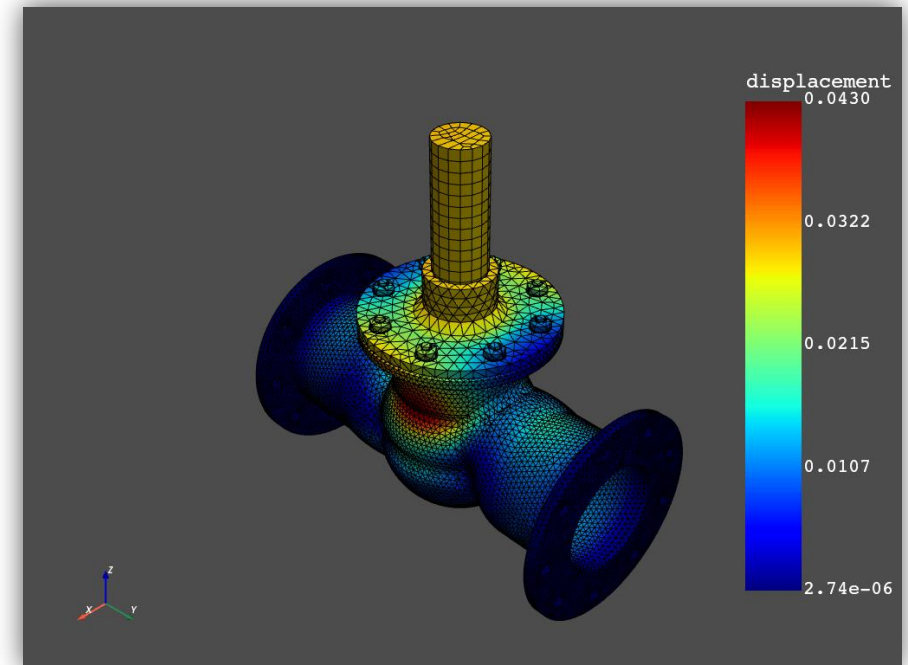
```
amplitude = stress_result.tensor_amplitude  
stress.plot_contour()
```



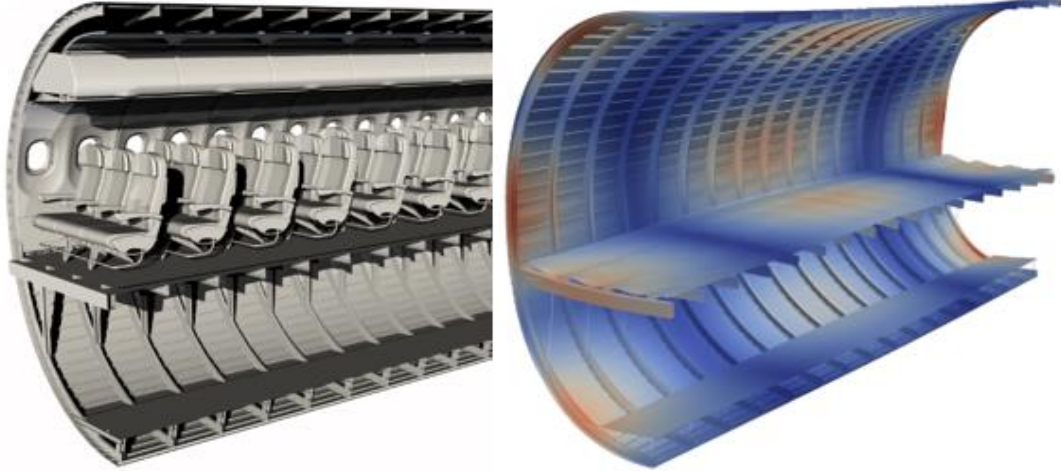
Use PyAnsys to:

- Plot data in .rst file thanks to DPF-Post

```
# Get and plot total deformation  
displacement = solution.displacement()  
total_deformation = displacement.norm  
total_deformation.plot_contour(show_edges=True)
```

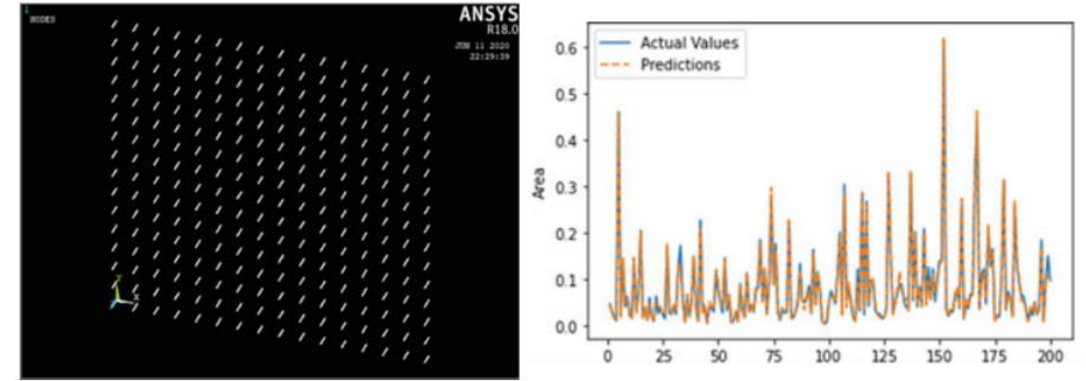


Current use cases of this technology



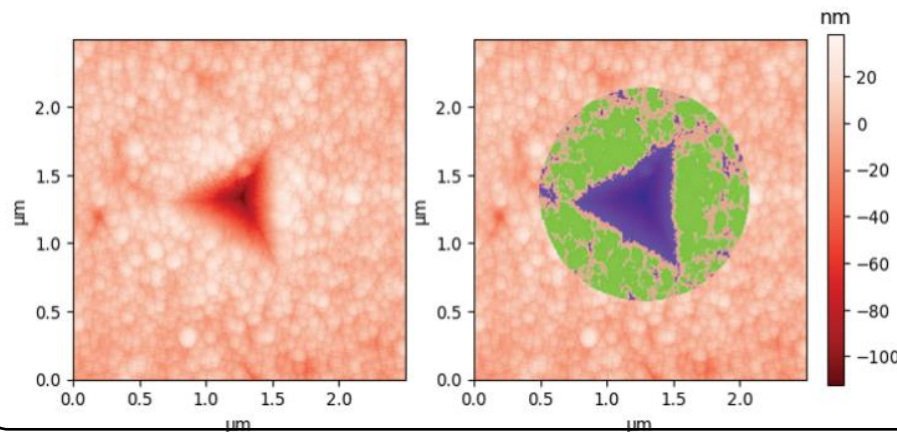
PyAnsys used in Cabin Design Process

C. Hesse, P. Allebrodt, and J.-N. Walther, "Integration of multi-physics analysis into the cabin design process using virtual reality," in *AIAA AVIATION 2021 FORUM*, 2021, pp. 1–12, doi: 10.2514/6.2021-2776.



PyAnsys used in Delamination detection using ML Techniques

T. S. Chittala, R. G. Burela, and S. A. Ponnusami, "Delamination Detection and Localization in Laminated Structures Using Machine Learning Techniques," in *Advances in Interdisciplinary Engineering: Select Proceedings of FLAME 2020*, 2020th ed., P. S. Niraj Kumar, Szalay Tibor, Rahul Sindhwani, Jaesun Lee, Ed. Springer, 2020, pp. 215–225.



PyAnsys used in studying Nanoindentation of thin metal films

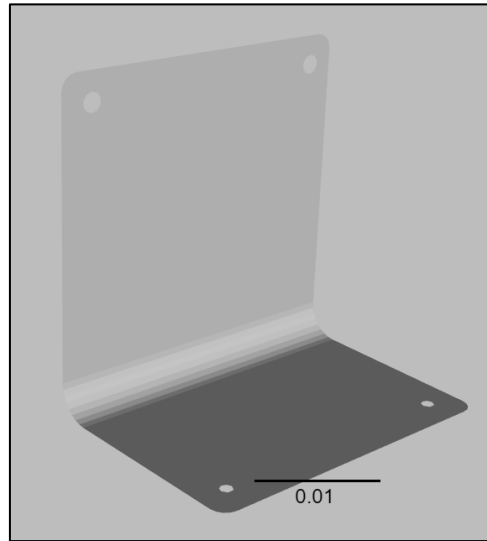
N. Johrmann, R. Ecke, and B. Wunderle, "Nanoindentation as part of material characterization of thin metal films," *2020 21st Int. Conf. Therm. Mech. Multi-Physics Simul. Exp. Microelectron. Microsystems, EuroSimE 2020*, no. 3, 2020, doi: 10.1109/EuroSimE48426.2020.9152706.

ML Example: Topographical Optimization using RL



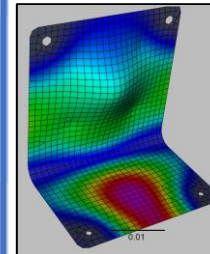
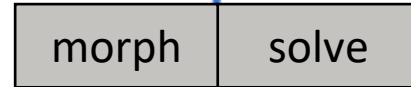
MDP Description

- Action:
 - morph point
 - morph direction
- State:
- morph extent
- Reward:
 - Increase freq/stiff
 - penalty for distortion

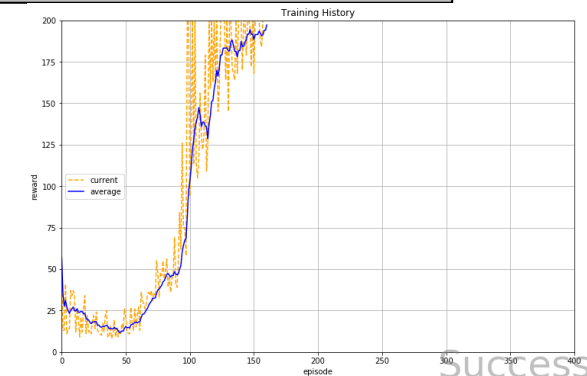
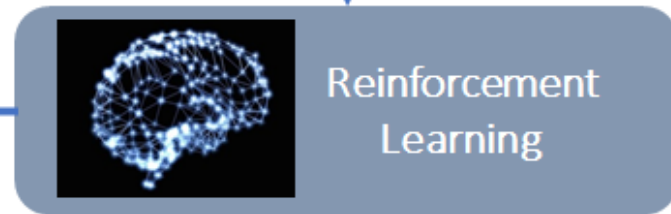
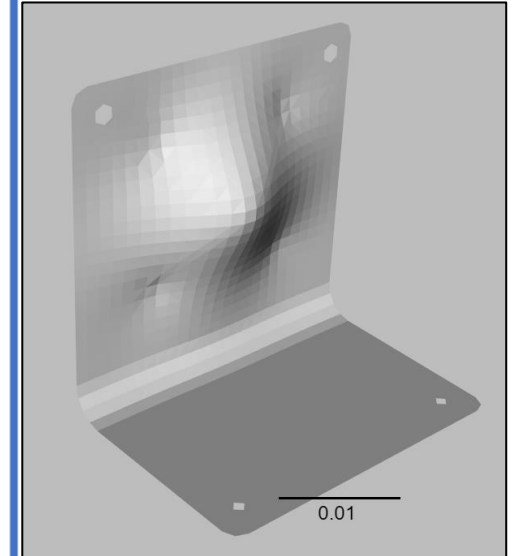


RL Algorithm

- Reinforced Learning
- Find sequences of morphing operations that maximize stiffness



receive a reward



Success!



Documentation & Help?

Source Code: <https://github.com/pyansys>

Documentation:

- Access from GitHub
- Direct links:
 - <https://mapldocs.pyansys.com/>
 - <https://dpfdocs.pyansys.com/>
 - <https://postdocs.pyansys.com/>
 - <https://aedtdocs.pyansys.com/>

Contribute/Post-Issues directly on Github:

The screenshot shows the GitHub organization page for PyAnsys. At the top, there's a navigation bar with 'Overview', 'Repositories 31', 'Packages', 'People 41', 'Teams 1', and 'Projects'. Below this, a 'Pinned' section displays six repository cards: pymapdl (Python interface to ANSYS result files), PyAEDT (AEDT Python Client Package), pymapdl-reader (Legacy binary interface to MAPDL binary files), DPF-Core (Data Processing Framework - Python Core), DPF-Post (Data Processing Framework - Post Processing Module), and DPF-Pre (Data Processing Framework - Pre Processing Module). Each card shows the repository name, a brief description, and statistics like stars and forks.

Two screenshots of GitHub issue trackers. The left screenshot shows the 'Issues' page for the 'pymapdl' repository, with 34 open issues. The right screenshot shows the 'Issues' page for the 'PyAEDT' repository, with 22 open issues. Both screenshots show a list of issues with columns for Author, Label, Projects, Milestones, Assignee, and Sort. Issues are categorized by labels like 'Bug', 'Support', 'Documentation', and 'New feature'.

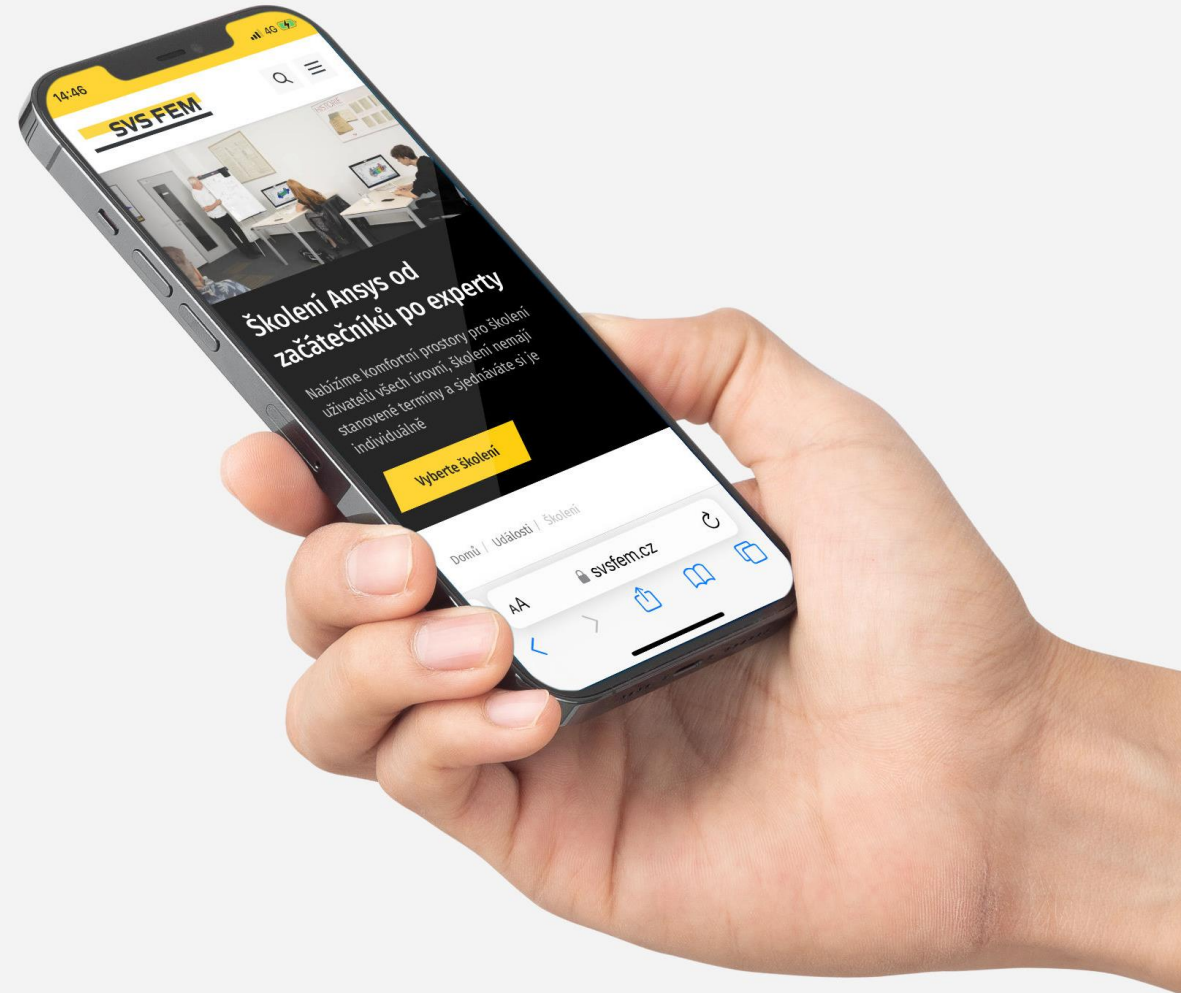
Conclusions

- PyAnsys introduces a **paradigm shift** in how Ansys simulation tools will be used going forward. Ansys is the '**first**' simulation software provider to introduce such **dynamic interaction** with its products.
- PyAnsys has been deployed on **GitHub** and is **controlled by ANSYS**.
- Ability to separate **Pre-processing, FE model** and **Post-processing** from outside the Ansys environment is a strength that PyAnsys has and will help us **deploy, maintain** and **scale** for applications across various industries.
- **AI/ML Community** can easily integrate ANSYS physics capabilities into their processes.

Chcete dál prohlubovat znalosti v Ansys?

Registrujte se na školení a semináře na www.svsfem.cz

Sledujte SVS FEM ve světě sociálních sítí



Díky za pozornost a zůstaňme ve spojení

 Zdeněk Čada



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